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**EXPLORING CURRENT ISSUES IN THE SUPPLY CHAIN  
MANAGEMENT IN THE OIL AND GAS INDUSTRY**

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## ABSTRACT

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<p>The importance of the oil and gas industry on the global market is undeniable. However, supply chain management in the industry is facing a lot of challenges caused by varieties of factors. The objective of the thesis is to provide a clear picture of the logistics optimization, uncertainties and further developments.</p> <p>After researching four biggest industry players it is concluded, that supply chain management is one of the most challenging part of the business. Nevertheless, research process provides an excellent overview of these companies, their current projects and geographical areas of development and exploration.</p> <p>The aim of the study is to provide an overview of logistics management in the oil and gas industry and its related activities that might be beneficial not only for the industry but also for the third parties – logistics companies.</p>		

### Key words

Downstream, gas, industry, oil, petroleum, supply chain

## **ABSTRACT**

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## 1. INTRODUCTION

The thesis titled “Current issues in the Supply Chain Management in the Gas and Oil Industry” is aimed to study and provide a clear idea of today’s supply chain optimization, development of the industry, new operational challenges, environment risk concerns and example of the worst disaster in the petroleum industry.

General understanding of the Supply Chain Management in the oil and gas production helps not only to worldwide development but also reduces health and safety risk. All discussions are based on the literature review, deep analysis of the news articles, online journals, numerical statistics and databases.

The main outcome of the research is, however, to offer different prospects of the view on the Supply Chain management and to reveal challenges that industry faces, and furthermore, environmental issues and problems.

More generally, knowledge about the Supply Chain in the petroleum industry, is highly valuable not only among suppliers and buyers, but as well for all countries that involved in the process from the very first steps. That means, broadly speaking, available up-to-date information, practical cases and solved current issues are immensely important and on top of that conclusion would be based on the research results and findings.

There were many steps and different phases to make this thesis done. A well-defined timetable and structured plan were determined from the very beginning. Plan was divided into two parts: theory and studying cases and writing part. Theory part includes using of different sources such as books, e-books, journals and news articles. Second part illustrated the main findings and results of the research process.

It was not a problem to come up with the topic, but the biggest challenge was to find good, updated and accurate information. Working with cases was challenging as well, because even official and highly trusted sources are providing different information.

There was no target company chosen as a case company, nevertheless few biggest petroleum companies were represented as an examples, to provide a clear and more detailed picture of the industry and its supply chain operations.

## 2. INDUSTRY OVERVIEW

World has changed dramatically in the past few centuries and it would be completely different without oil, gas and its products. Petroleum is a main energy source and using for the limitless variety of chemical products and manufacturing synthetic materials. No wonder that 20<sup>th</sup> and 21<sup>st</sup> centuries were named as ages of oil, because crude oil itself and its refined products have been essential to all aspects of modern society. (Vassiliou, 2009.)

There is no doubt that petroleum industry is one of the most important and significant sector of the economy today that engaged in production, processing, transportation, storage and sale of natural mineral resources - oil and related petroleum products. Related industries include geophysics, drilling, oil and gas production equipment. (Mast, 2005.)

Petroleum industry includes raw materials such as crude oil and natural gas. Process of production was briefly described by Hussain, Assavapokee & Khumawala (2006, 90-97). Production of the crude oil is a very long and time consuming process that has its origins from the offshore areas or deep underground. After distillation process of a crude oil different products of it are processed. Examples of the crude oil fractions are kerosene, fuel gas and liquefied petroleum gas. Petrochemical industry is a full of varieties different products for instance ethylene, benzene, ethylene, butadiene, xylenes and toluene that can also be produced to more specified products such as synthetics, rubbers, plastics, soaps and assortment of a healthcare products.

The petroleum industry essentially involves three main steps such as upstream, midstream and downstream. The thesis aim is to provide and observation conclusions and a clear picture about industry but mostly concentrating on the midstream sector. The midstream operation is usually included transportation (by tankers, railways, pipeline or trucks), storage of the refined or crude petroleum products and wholesale marketing as well. Transportation systems can be used to supply unpurified oil from the production sites to refine it and later distribute products to retailers and distributors. Distribution part of the refined crude oil and natural gas is called

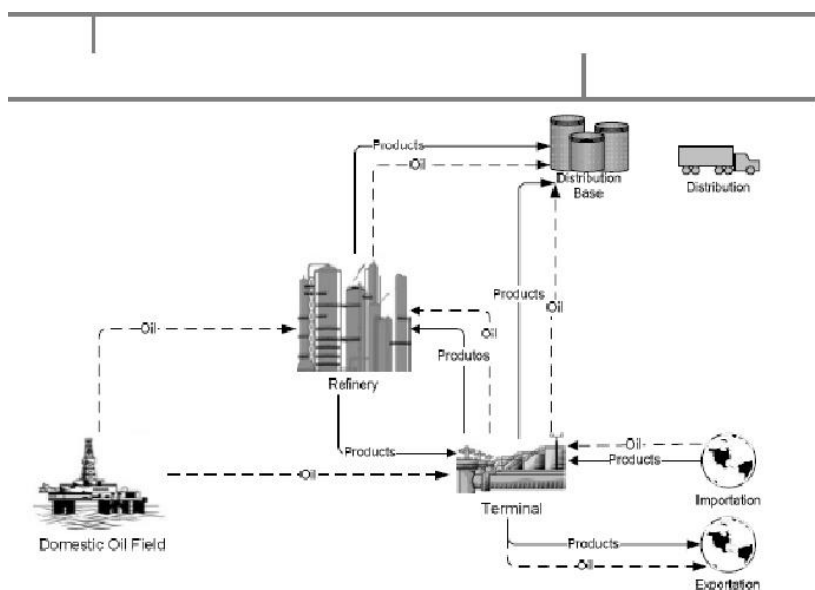
downstream. (Industry Overview from the Website of the Petroleum Services Association of Canada PSAC)

Supply chain in the gas and oil production is a necessary element of national economies and international relations between countries. Oil industry has a huge impact on the global economic tendencies and shows a growing demand in the recent few decades. (Hilmola 2011, 256-270.)

The oil supply chain is a very complex industry in comparison to any others. It is always a long and complicated journey for the crude oil to get to the refineries that could take a few weeks and several of participants. Production of the oil is mostly centered in the specific areas, although petroleum products supplied all over the world. (Hussain et al.2006, 90-97.)

One of the main goals for the oil companies is to deliver oil and its products safely, in the right time and for the best price. Oil supply chain is based on the classical model with the different stages. (Gainsborough 2006, 29-32.)

Graph 1 illustrates the typical oil supply chain.



GRAPH 1. Typical oil supply chain



### **3. TRANSPORTATION OF OIL**

#### **3.1 Pipelines and piping system**

The differences between the two are that a piping system can be generically defined as being inside a localized area to connect various vessels that are for reaction and/or storage. A pipeline system is more like a pure transport medium between two geographical positions. (Ellenberger 2010, 3-7.)

Nowadays, the most beneficial and environmentally friendly way to transport oil is through pipelines, which moves at very high speed under high pressure, reaching up to three meters per second. The pipeline can be ground and underground and lay according to the terrain relief. (Ellenberger 2010, 3-7.)

The structure of pipes for pipeline includes highly plastic steel, reinforced plastic, which ensures its high reliability, resistance to damage, temperature and corrosion.

Ground and underground pipelines has its pros and cons. First of all, ground pipeline is beneficial because in the case of an emergency, the damage is easier to find and fix than if it was located on ground. Underground pipeline has its advantages. For example, it much better protected against environmental influences than the ground method. (Ellenberger 2010, 3-7.)

#### **3.2. Transportation by sea**

For the transportation of oil through waterways are used tankers and supertankers (extra-large ocean tankers with a displacement of 320 000 metric tons which is used to transport crude oil from the loading port to the place of an overload or directly to an oil refinery).

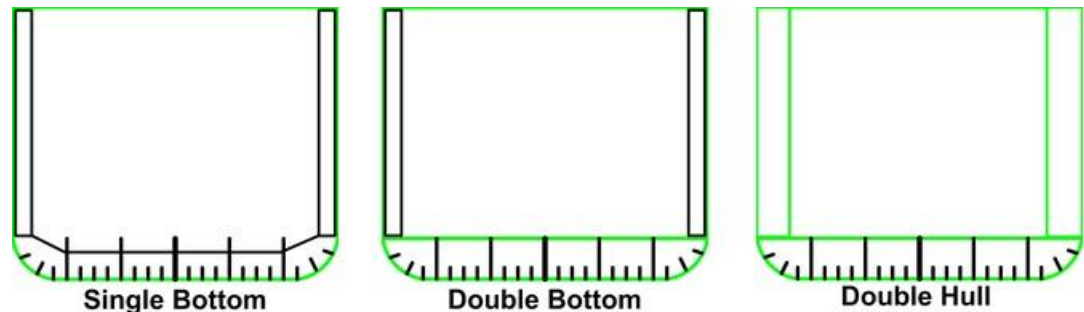
- GP (General Purpose) - Low-tonnage tankers (6000-16 499 m); used for special transportations, including carriage of bitumen;
- GP - general purpose tankers (16 500-24 999 tonnes); used for the transportation of petroleum products;
- MR (Medium Range) - Medium-tankers (25000-44999 tonnes); for the transportation of petroleum or petroleum products;
- LR1 (Large / Long Range1) - oiler - large tankers class 1 (45000-79 999 m); used for the transportation of dark petrocargoes;
- LR2 - large tankers Class 2 (80 000-159 999 tones)
- VLCC (Very Large Crude Carrier) - large tankers of Class 3 (160 000-320 000 tonnes);
- ULCC (Ultra Large Crude Carrier) - supertankers (more than 320 000 tonnes); for the transportation of oil from the Middle East to the Gulf of Mexico.
- FSO (Floating Storage and Offloading unit) - supertankers (more than 320 000 tonnes); for storing and unloading oil into smaller tankers.

Tanker - sea or river cargo vessel is designed for the carriage of liquid cargoes. Tanker hull is a rigid metal frame to which is attached a metal plating. The housing is divided by sections into a number of compartments (tanks), which are filled with liquid cargo. Volume one tank vary from 600 to 10 000 m<sup>3</sup> and more for large tankers. Supertanker - supersized ocean tanker, with a displacement of 320 000 metric tons is used to transport crude oil from the port of loading to the place of an overload or directly to an oil refinery. Designation Classification - ULCC (Ultra-large crude carrier). Also can be use as a giant floating storage of oil. (Hayler 2003, 2-14.)

Nowadays it is forbidden to build tankers with single plating (single hull tankers), after a couple of major accidents that received wide resonance in the late 20<sup>th</sup> century. For safety reasons, in 2003 the European Union has approved the concept to prohibit the carriage of

heavy fuel on board vessels which are not equipped with a double hull and has decided to phase out single hull oil tankers by 2010. (Hayler 2003, 2-14.)

Graph 2 indicates watertight hull sections (dark lines) and non-watertight structural elements (light lines).



GRAPH 2. Hull elements (Herbert, 2006.)

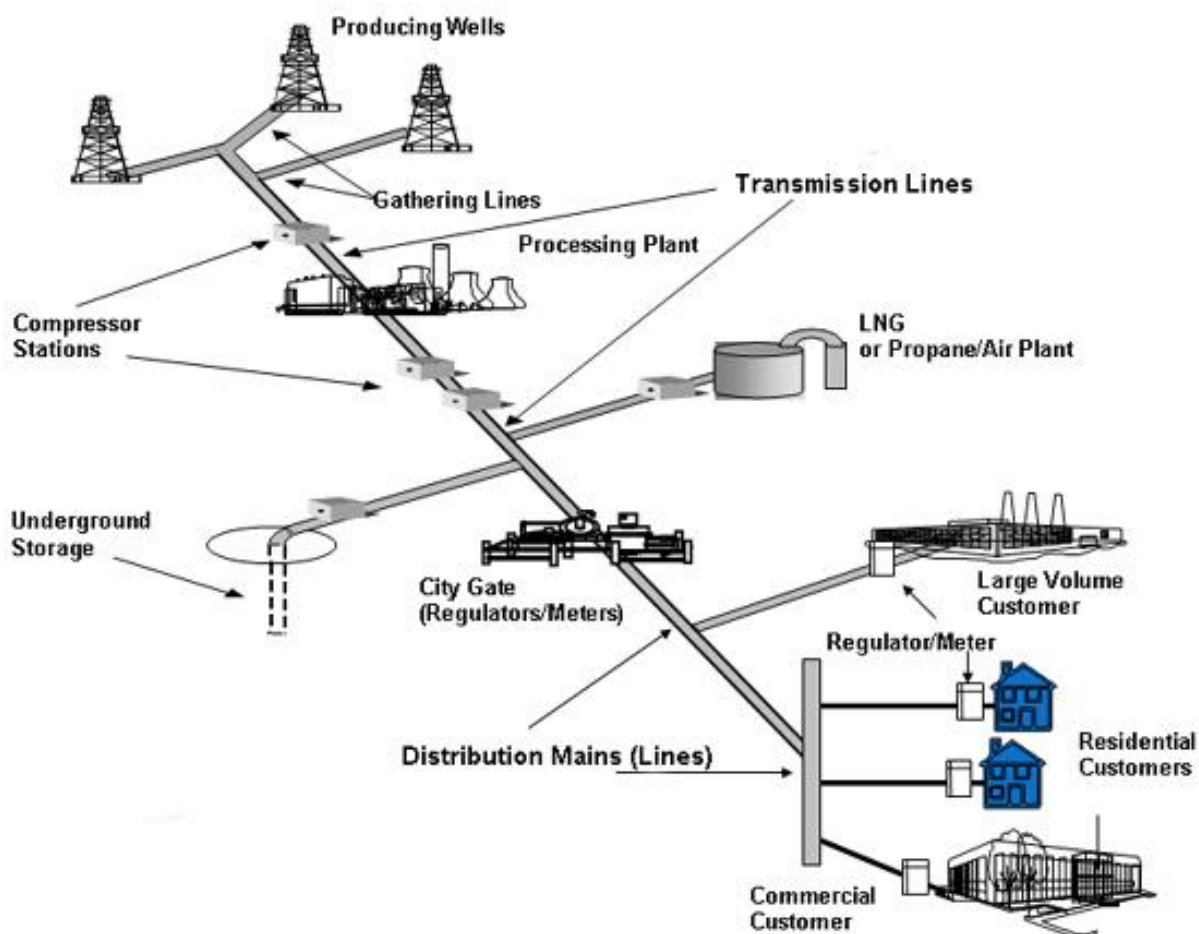
### 3.3. Transportation by railway

There is one another way to transport oil – transport it by railway. This method of transportation is one of the fastest and not dependent on the weather conditions. Despite on the convenience and quickness of railway transportation, it cost much more than transportation petroleum and its products by pipelines. In such a way, even in high developed railway systems, oil suppliers prefer to use pipelines.

In addition to this, some of petroleum products such as LNG (liquefied natural gas), diesel fuel and gasoline much more convenient to transport by tank trucks. Transportation this way, anyhow, increases the final cost of oil that is why this kind of services provided only within a limited distance – not longer than 300-400 kilometers.

#### 4. TRANSPORTATION OF GAS

Movement of natural gas is a very challenging and unique process. From the well where natural gas is produced it has to travel long distance before it reach final destination. The graph 3 below illustrates scheme of the complex natural gas transportation system and all elements that involved.



GRAPH 3. Natural gas transportation system. (Third Eye Z Solutions, 2011.)

According to some experts, there are only three major types of pipelines, but nowadays distinguished a few more additional.

First and major type is the gathering system. Main purpose of the gathering lines is to collect gas from different flowlines and flow it to another points. That could be storages, tankers, docks etc.

This system consists of low pressure and diameter of the pipelines is usually small or medium size, under 45cm. Carbon dioxide or sour gas that transporting by gathering pipes is very corrosive that can affect pipeline and the whole process of transportation must be done carefully. Gathering pipelines also can be used for transportation of crude oil and natural liquid gases such as ethane, propane and butane. (Mohitpour 2003.)

Second type is a transmission pipelines. These pipelines are using for carrying oil and natural gas across a long distance and well-known as “energy - highways” because they are located within countries and international boundaries.

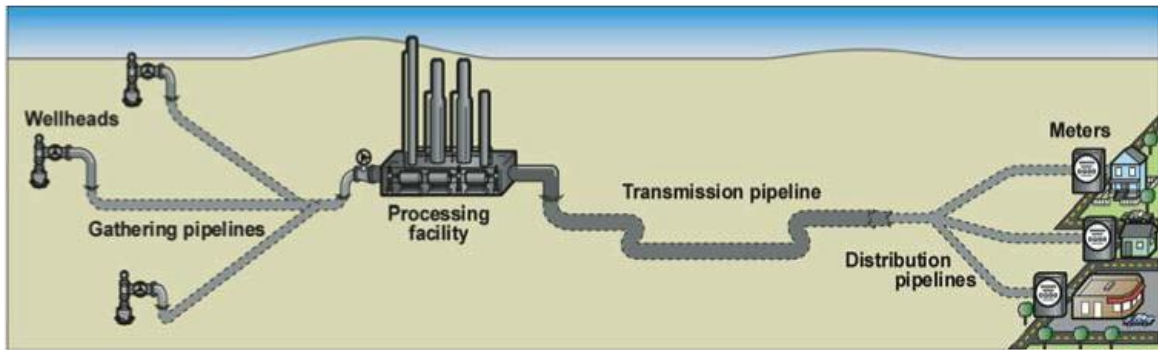
Transmission pipelines separates into two lines: natural gas transmission lines that are carrying only gases and crude oil transmission lines that intended for different types of products such as liquids, crude oil and petroleum refined products.

Average size of these pipelines is from 10 cm to 122 cm but mostly they are smaller than 25 cm in diameter (Mohitpour 2003.)

Distribution pipelines are the middle point between transmission lines with a high pressure and service lines that delivering products to individual customers with a low pressure. These types of pipelines are mostly operating a medium pressure.

Size of distribution pipelines is regulated federally as well as amount of pressure, but mostly they small sized from 1, 5 cm to 15 cm. Usually these pipes are made from steel and cast iron. (Mohitpour 2003.)

Graph 4 bellow provides an example of three main pipelines and how they are operating as a unified system.



GRAPH 4. Three main pipelines (Third Eye Z Solutions, 2011.)

Additional elements in the pipeline system are flowlines and service pipelines. Flowlines is a connection between wellhead and storages or stations. These lines are easy to corrode and methane leakage is their biggest disadvantages that nowadays named as the biggest sources of accidents and emissions in the oil and gas industry. (Mohitpour 2003.)

A Service pipeline is an exceptional element because mostly it is not differ from distribution pipelines. Main difference between them is that service pipelines deliver gas only to individual customers and connected to a meter. (Mohitpour 2003.)

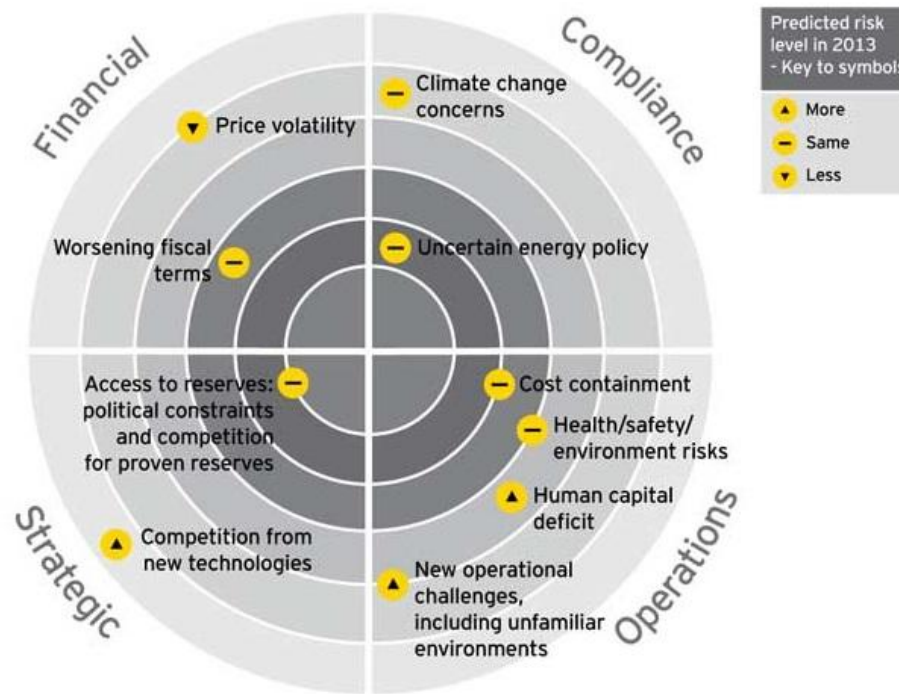
## **5. ISSUES AND THREATS**

### **5.1. Main threats in the Gas and Oil supply chains**

These years, the oil and gas industry see environmental accountability as a top priority, underlined by the intersection between public concern and industry efforts. Many companies are facing different challenges with every aspect of the industry. At the moment, companies struggle with governmental policies and political situations. Specifically: regulatory and legislative changes and increased cost of compliance, fickle oil and gas prices, general national or global economic concerns and overall industry competition.

Additionally, some reliable source such as oilprice.com (The No. 1 source for oil and energy news) claimed that environmental issues, climate change concerns and human capital deficit are even more important risk factors than any others.

A well known multinational firm Ernst & Young (EY) that provides professional services including financial accounting advisory services, climate change and sustainability service, international tax service, human capital, customs transactions tax and moreover risk and performance improvement came up with the simple device they called Risk Radar that illustrated in the graph 5.



GRAPH 5. Model of the Risk Radar. (Ernst & Young, 2013.)

Radar is a basically a pie chart that allows to represent a snapshot of the top 10 risks in the oil and gas sector. EY interviewed industry analyst and executives to present ideas about the greatest challenges to oil and gas companies for the next few years. The radar is divided into four equal sections representing main risk areas: Financial, Compliance, Strategic, Operations, Arrows indicate whether the correspondents thought the risk would fall or also possibly rise in importance by the year 2013.



## 5.2. Example of oil spill in the Gulf of Mexico

20th of April 2010 was a significant day for British Petroleum company and the crew of Transocean's Deepwater Horizon. They were ready to celebrate the Macondo well completion and the rig's seven years without any accidents. Unfortunately joy gave way to tears. The whole world was shocked hearing news that in the evening of April 20 at approximately 10 pm high-pressure methane gas started to burst up from the drilled Macondo well, expanded into the drilling riser and rose into the drilling rig, where it exploded.

The Deepwater Horizon sank after the fire that last for 36 hours on the morning of 22 April 2010. The explosion killed 11 workers and 17 were injured, the rest of the crew 94 people were rescued by helicopter and lifeboat. As a result of this huge blowout the pipeline that proceeds crude oil from the sea bottom to the platform got damaged.



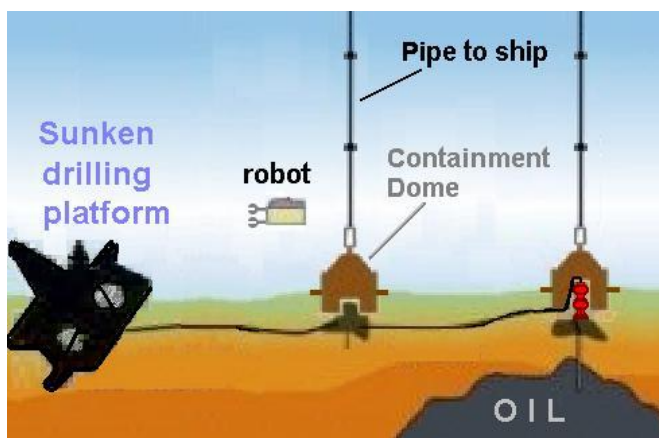
GRAPH 6. Extinguishing the fire. (BBC News, 2010.)

Scientists discovered an oil leak when a large oil slick began to spread in the water at the wellsite position. It happened on the afternoon of 22 April just after the oil rig has sunk. Oil was leaking from the rig to the water at the rate of about 6 millions liters of crude oil per day

and last for 87 days. The biggest part of the oil spill was in the north-eastern side of the gulf, changing its configuration and the area by the wind and local underwater flows.

The United States Government estimated the total outflow at 4.9 million barrels (or 780.000 m<sup>3</sup>). Generally, over 200 million US gallons of crude oil was spilled into the water of the Gulf of Mexico, estimated from 8% to 31 % bigger than the previous largest one making it one of the worst disasters in history. (BBC news 2010.)

First successful attempt to stop leaking has been done on 3 June 2010. Drill pipe has been cut off from coming out of emergency well above the blowout preventer (Special device for sealing the wellhead) on a depth of 1.5 kilometers. A protective siphon has been successfully placed on the cut section making oil and gas from the emergency wells partially enter the tanker reservoirs on the water surface.



GRAPH 7. Model of the 2 oil leaks from the fallen pipeline

On 4 of August British Petroleum claimed that leak has been stopped after final successful operation called Static Kill (complete stop of leakage) when firstly drilling mud and then cement was pumped slowly from the top into the well-head with a rate about 320 liters (2 barrels) per minute.

Robert Bea an engineering professor at the University of California–Berkeley commented the situation: "It's clear that the problem is not technology, but people. It was a chain of important errors made by people in critical situations involving complex technological and organization systems." (International Energy Agency, 2010.)

### **5.3. Eco-impact of the spill and clean-up process**

Over an 1100 miles of the sea coast was polluted. Few American states such as Louisiana, Alabama, Mississippi, Florida and Texas claimed about the damages. US Government reported that the Deepwater Horizon disaster is confirmed as the biggest oil spill disaster in the history. (BBC news, 2010.)

Impact of the spill covered so many areas, in particular: ocean, surface, seafloor, coast pollution, causing death of birds and animals, plants and prohibition of fishing that covered over one third of the gulf water area.

How much do we really know about post spill period and cleanup process? At the beginning of the process to liquidate accident aftermath has been used method called “in-situ burning” and all in all there have been produced 411 burnings which negatively affected environment. (BBC News, 2010.)

Second important operation method after burnings was the final oil gathering from the water surface and collecting oil from the bottom of the Gulf which was already mixed with sand and thirdly, cleaning the coast. Collecting oil from the water was done by skimmers-ship. (On scene Coordinator Report on Deepwater Horizon Oil Spill, 2011.) Besides of that they were using oil eating bacteria that consumed some oil and digested natural gas as well. (Valentine, 2011.) In addition to this, biggest part of cleaning was done by volunteers, investors and owners of cleaned areas. About eight thousands animals including fish, birds, turtles and mammals had been found dead in the coast area. (Biello, 2010.)

Given the scale of the accident, many scientists predicted that big amount of contaminants in the water will preserved for many years. However, by the end of September 2010 a huge underwater plume of methane and other gases almost disappeared. (BBC News, 2010.)

Nevertheless, in 2012 scientists and researchers keep claiming that oil from bottom of the sea floor does not seem to be vanished. Tar balls still came up along the coast of Louisiana and Mississippi and erosion of coastal lands keep growing and causing death of plants, trees and swamp grass from noxious substances. (Dermansky, 2013.)

In 2013 researchers found out that oil in the water causing under water rain of oily particles and does not seem to have any decreased of oil on the bottom. This could affect natural recourses, environment and health for generations because chemical hazards and oil remain in the food chain. (CBS News.)

There is no way to doubt that BP oil spill in the Gulf of Mexico is the biggest and one of the worst disasters in the petroleum history.

## 6. CASES STUDIES

### 6.1. Saudi Aramco Case

Saudi Aramco is by far the biggest Oil and Gas Company in the world with \$1 billion revenue per day and 12,7 million barrels of oil. Being a fully integrated global leader in petroleum and chemicals enterprise Saudi Aramco is moving further downstream into chemicals production. With a great strategy by the year 2020 company is seeking more opportunities to development. (Saudi Aramco Annual Report, 2013.)

Table 1 is providing information about new discoveries, workovers and wells completed for the year 2013.

TABLE 1. Discoveries, workovers and wells completed. (Saudi Aramco Annual Report. 2013.)

NEW DISCOVERIES		WORKOVERS		WELLS COMPLETED	
<b>Oil fields</b>	3 (Al-Haryd, Duhul & Salsal)	<b>Oil wells</b>	202	<b>Oil exploration</b>	29
<b>Gas fields</b>	2 (Turayqa and Mihvaz)	<b>Gas wells</b>	24	<b>Gas exploration</b>	21 (Conventional)
<b>Total number of oil and gas fields</b>	121	<b>Water wells</b>	50	<b>Gas exploration</b>	29 (Unconventional)
				<b>Oil development</b>	216
				<b>Gas development</b>	66

By the year 2013 global economy showed positive signs of growth and as a result growing demand and opportunities for energy.

Khalid A. Al Falih, President and Chief Executive Officer proudly claimed that 2013 was not only 80<sup>th</sup> anniversary of the company, but one of the most productive years of their history. From the upstream to downstream Saudi Aramco combines and generates new recourses and know-how technology. Table 2 illustrates key figures in Oil and Gas Reserves and Production for 2013. (Saudi Aramco Annual Report. 2013.)

TABLE 2. Saudi Aramco key figures of 2013. (Saudi Aramco Annual Report. 2013.)

<b>Oil Reserves and Production</b>		<b>Gas Reserves and Production</b>	
<b>Recoverable crude oil and condensate reserves</b>	260.2 billion barrels	<b>Gas reserves</b>	288.4 trillion standard cubic feet
<b>Average daily crude oil production</b>	12.7 million barrels	<b>Gas production (raw gas plants average per day)</b>	11.0 billion standard cubic feet
<b>Annual crude oil production</b>	3.4 billion barrels	<b>Gas production (annual)</b>	4.0 trillion standard cubic feet

Table 2

In downstream part it is necessary to consider the fact that for 2013 company increased sales Gas Supply to the domestic Master Gas System and furthermore commissioned the Saudi Aramco Total Refining and Petrochemical refinery (SATORP) and keep progressing several other petrochemical projects.

Except domestic refineries Saudi Aramco has concentration in refineries in Asia (Korea, Japan, and China) and United States. According to this, exports to Asia for 2013 (As a percentage of total exports) are following:

TABLE 3. Percentage of refineries abroad (Saudi Aramco Annual Report. 2013.)

<b>Crude oil</b>	53.8%
<b>Refined Products</b>	46.6%
<b>NGL (Natural Gas Liquids)</b>	27.9%

In 2013 Saudi Aramco signed Corporate Purchase Agreements (CPA's) with four leading global suppliers that valued over \$4 billion. Signing the agreements been targeted to cover materials and services for drilling completion equipment and furthermore to improve partnership between Saudi Aramco and its strategic partners and increased foreign investment. (Saudi Aramco Annual Report. 2013.)

## 6.2. Gazprom Case

Russia's Gazprom is not only energy giant but the largest producer of natural gas. Operating 8.1 million barrels per day, Gazprom's profits are over than \$40 billion a year and been rated second biggest oil company in the world (Forbes, 2013).

Operating major business sections such as exploration, drilling, manufacturing, selling and supplying of natural gas, gas condensate and oil, company also generating and marketing heat and electric power. In addition to this, Gazprom holds the world's largest natural gas reserves and the only producer and exporter of Natural Liquefied Gas in Russia. (Gazprom Annual Report, 2013.)

Reliable gas supplier company owns the world's largest gas transmission pipeline network with the total length 168.000 kilometers and selling over half of overall production to Russia and international consumers in more than 30 countries. Table 4 illustrates key figures in Oil and Gas Production for 2013. . (Gazprom Annual Report, 2013.)

TABLE 4. Gazprom key figures of 2013. . (Gazprom Annual Report, 2013.)

<b>Oil Production</b>		<b>Gas Production</b>	
<b>Average daily crude oil production</b>	8.1 million barrels	<b>Gas condensate (annual)</b>	14.66 million tons
<b>Annual crude oil production</b>	33,84 million tons	<b>Gas production (raw gas plants average per day)</b>	1.335 million cubic meters
		<b>Annual gas production</b>	487,38 billion cubic meters

The Unified Gas Supply System of Russia operates transportation and underground storage. It involves all facilities like natural gas, fields of gas condensate, underground gas storage facilities (UGSFs), gas distribution stations (GDSs), compressor stations and trunk gas pipelines. Russian pipeline system is absolutely unique and guarantees trusted and safe gas supplies. Gas transportation system that supplies gas through pipelines measuring 4,2 thousand km overall. (Gazprom Annual Report, 2013.)

Underground gas storage facilities (UGSFs) are a well-developed network that located in major expenditure areas and guarantee reliable expert of gas supplies. Gazprom operates 22 UGSFs at 26 storage sites in Russia with daily throughput capacity about 56,7 million cubic meters. Amount of equipment failures at Gazprom's trunk pipelines in Russia in 2013 was only eight, in comparison with last year (2012) it is doubled less. Table 5 provides information about Gazprom Group's major gas transportation projects. (Gazprom Annual Report, 2013.)



TABLE 5. Gazprom Group's major gas transportation projects. (Gazprom Annual Report, 2013.)

<b>Name</b>	<b>Purpose</b>	<b>Length</b>	<b>Number of compressors or stations</b>	<b>Annual capacity</b>	<b>Life of the project</b>	<b>Project progress (as of December 31, 2013)</b>
<b>Gryazovets – Vyborg (expansion)</b>	Gas supply to consumers of the North-West of Russia.	216 km	-	9.4 bcm	2014–2017	Project documentation is under development.
<b>Expansion of UGSS for providing the South Stream gas pipeline with gas</b>	Gas transportation through the territory of Russia for providing the South Stream gas pipeline with gas.	2,506 km	10 CS	Up to 63 bcm	2014–2017	Constructions work in progress
<b>South Stream</b>	Transportation of gas from Russia through the Black Sea and the territories of South and Central Europe.	1,455 km	8 CS	Up to 63 bcm	2015–2018	Investment stage has been ensured by Russia and foreign investors
<b>Murmansk – Volkhov</b>	Transporting gas from the Shtokmanovskoye field to UGSS.	1,365 km	Up to 10 CS	Up to 46 bcm	-	The commission will be determined after the acceptance of final investment decision regarding field.
<b>Bovanenkovo – Ukhta</b>	Pipeline system to transport gas from the Yamal Peninsula to the Central regions of Russia.	2,400 km	18 CS	120 bcm	2014–2019	In 2013 5 CS with 628 MW capacity were Commissioned. In progress.

### 6.3. Exxon Mobil Case

Exxon Mobil is an American multinational oil and gas company ranked 4<sup>th</sup> biggest in the world with \$40 billion in annual profits and 5,3 million barrels of oil per day. Exxon Mobil is also the largest refinery in the world (Forbes, 2013).

Despite of global economic changes and uncertainty in 2013 company showed great results with operating and financial performance. The beginning of 2013 started with a contribution in Wolverine Pipeline system (company that transporting liquid petroleum products from refinery to terminals) to improve mid - continent logistic. Second important highlight was the beginning of construction of a new crude oil rail terminal between US and West Canada. Terminal will begin to operate in 2015 with a capacity of over 250 thousand barrels per day. (Exxon Mobil Annual Report, 2013.)

Good example of successful and targeting investment is a Singapore Chemical Expansion project that has been completed in 2013. This plant is located very uniquely in Asia-Pacific region for operating between China and Indian subcontinent. The Singapore chemical facility holds now about one quarter of all company chemical capacity. One more significant feature about the project is that the steam-cracking capacity was more than doubled and in addition to this new diesel hydrotreater was commissioned to increase ultra-low sulfur diesel production quantity. (Exxon Mobil Annual Report, 2013.)

Exxon Mobil downstream is a varied business with a world's largest refiner and outstanding distribution facilities. Holding an ownership interest with distillation capacity of 5.3 million barrels per day in 31 refineries. Additionally, they have base stock capacity of 126 thousand barrels per day. Company is integrating with more than 75 percent of refining operations combined with chemical and lubricant production, which providing optimization capability across the whole chain. Table 6 illustrates key figures in Oil and Gas Reserves and Production for 2013. (Exxon Mobil Annual Report, 2013.)

TABLE 6. Exxon Mobil key figures of 2013. (Exxon Mobil Annual Report, 2013.)

<b>Oil Reserves and Production</b>		<b>Gas Reserves and Production</b>	
<b>Average daily oil production</b>	5.3 million barrels	<b>Average daily gas production</b>	11.8 million cubic feet
<b>Annual oil production</b>	25.2 billion barrels	<b>Gas plant liquids (worldwide)</b>	259
<b>Refinery throughput (per day)</b>	4.5 thousand barrels	<b>Natural gas sales (per day)</b>	14.3 million cubic feet
<b>Petroleum production sales (per day)</b>	5.8 thousand barrels	<b>Annual gas production</b>	7.1 trillion cubic feet

#### 6.4. Petro China Case

Petro China Company Limited is a Chinese oil and gas company, the largest of China's three state controlled oil giants owned by China National Petroleum Corporation. With a capacity of 3.9 million barrels per day of output company been ranked 7<sup>th</sup> in the Forbes publication for 2013 (Forbes, 2013).

In 2013 Petro China kept to maintain its rapid growth. In every business aspects such as exploration, production, refining, marketing and transporting company continued to prioritize its strategy for successful development. (Petro China Annual Report, 2013.)

Company was focused on profitability, safety and quality of the sales. Concentrating on the oil and gas pipelines innovation, Petro China completed and put into operation new connection lines (The Horgos – Lian muqin, the Zhongwei – Guijang Connection line, Lanzhou – Chengdu Crude Oil Pipeline, the Third West – East Gas Pipeline and Tangshan LNG). (Petro China Annual Report, 2013.)

Meanwhile, domestic oil and gas pipelines system have a total length of 71,020 km, including natural gas pipelines 43,872 km, crude oil pipelines measured 17,614 km and length of pipelines for refined product is 9,534 km. Table 7 shows key figures in Oil and Gas Reserves and Production for 2013. (Petro China Annual Report, 2013.)

TABLE 7. Petro China key figures of 2013. (Petro China Annual Report, 2013.)

<b>Oil Reserves and Production</b>		<b>Gas Reserves and Production</b>	
<b>Crude Oil output</b>	932.9 million barrels	<b>Natural gas output</b>	2,8 trillion cubic feet
<b>Reserves of crude oil</b>	10,8 million barrels	<b>Reserves of natural gas</b>	69,3 billion cubic feet

## 7. COMPARISON OF THE CASES

The top four companies in the oil and gas industry, Saudi Aramco, Gazprom, Exxon Mobil and Petro China have been chosen as case examples. Companies had been ranked and compared based on variety of elements: output capacity, revenues and profits, reserves of oil and gas. Annual reports, home web sites and famous business magazine “Forbes” have been used as sources for background information about companies and their day to day transactions.

While some differences between average daily oil and gas production are evident, the similarities with marketing and supply chain management are striking. All four companies are seeking for more opportunities to develop and improve international relationships with foreign partners.

Thereby, Saudi Aramco increased sales of gas and keep progressing in several petrochemical projects, but nevertheless, the most considerable project was Corporate Purchase agreement, that Saudi Aramco signed with four leading global suppliers to enhance foreign investments.

Year 2013 was also successful for Gazprom Group that was involved in at least six gas transportation projects. In addition to this, company decreased amount of equipment failures in twice, in comparison with the previous year.

American multinational company Exxon Mobil completed a Singapore Chemical Expansion project, that increased steam-cracking capacity and straightly increased diesel production quantity. Besides, company constructing a new crude oil rail terminal between US and Canada that would help to improve carrying capacity.

Chinese petroleum giant Petro China concentrated on the oil and gas pipelines innovation and also completed eight new connection lines.

To summarize these facts, it is clear that four biggest oil companies located in the different parts of the world are continued progressing and developing. Year by year they are achieving improvements in all business aspects: exploration, refining, producing and transportation. Moreover, participating in international projects with foreign investors and supply chain

optimization make them leaders in international arena. In table 8 we could see information about key figures of the four biggest oil and gas players.

TABLE 8. Key figures of the four biggest oil and gas players.

	Oil Production		Gas Production	
	Daily Average	Annually	Daily Average	Annually
<b>SAUDI ARAMCO</b>	12,7 million barrels	3,4 billion barrels	11.0 billion cubic feet	4.0 trillion cubic feet
<b>GAZPROM</b>	8,1 million barrels	33,8 million tons	1,3 billion cubic meters	487,3 billion cubic meters
<b>EXXON MOBIL</b>	5,3 million barrels	25,2 billion barrels	11,8 billion cubic feet	7.1 trillion cubic feet
<b>PETRO CHINA</b>	3,9 million barrels	932, 9 million barrels	7.0 billion cubic feet	2.8 trillion cubic feet

## 8. CONCLUSION

To draw the conclusion the outcome of analysis, research process and summarized facts are addressed in this thesis study. The arguments that have been presented, show that petroleum industry itself is one of the most important and significant industries nowadays.

The structure of the thesis is based on the main themes from supply chain management to transportation or midstream, in the industry. It is noted several times, that research process was focused on the downstream operations in the chain and highlighted mostly in the cases that have been presented.

The literature review describes the main features about petroleum and oil industries, characteristics and position in the extremely challenging market environment. Complexity and inflexibility of the oil supply chain cause uncertainties that have straight impact on the economical and political situations. Example of the Sector Risk Radar by Ernst & Young Corporation clearly illustrates the main threats in the gas and oil supply chain in four sections: financial, strategic, operations and compliance. Each of the section shows that the amount of the money involved in the business obliges to operate flawlessly in the areas of marketing and logistics.

Experts are convinced that optimization of the supply chain is a key to success for the whole industry aiming to find a possible solution avoiding threats and uncertainties. Following this statement industry needs to control, maintain and improve supply chain with the overall company planning.

The analysis of several companies and British Petroleum spill case helped to highlight and explore thesis topic from the different angles. Comparing four biggest oil giants in 2013 can be noted a detailed profile about their downstream and midstream processes. By analyzing their annual reports, supply chain has a central importance in the oil gas industries and it keeps developing year by year.

This research process provides an excellent overview of oil and gas companies, their current projects and geographical areas of development and exploration that might be beneficial for

the third parties – logistics companies. These companies in its turn can improve their offerings and become aware of the differences in the petroleum and gas industry to be fully responding of their needs.

Nevertheless, there are still many issues for the further research. For instance, contacting one oil company and have interview their downstream supply chain unit or logistic company that is working directly with an oil industry. That would help to deepen the understanding of supply chain management with a potential theoretical suggestions and statistical models as well.



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